COVID-19 Considerations in the Deployed Setting

14 Apr 2020

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Disclosure

This presentation is based on the presenter's personal literature review, field experience and utilization of Centers for Disease Control and Prevention and the World Health Organization. It does not represent the views of the Department of Defense or the Joint Trauma System, nor does it serve as official guidelines.

Agenda

- Background
- Symptoms
- Quarantine vs Isolation
- Levels of care
- Diagnosis
- Management
- Infection Control

Background

- ***All ages can be infected.***
  - In China:
    - 80% of deaths are in >60 year olds
    - 75% pre-existing conditions – hypertension (HTN), chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), cancer (Ca) or heart disease)
    - 71% of cases are male
  - 81% mild, 14% “severe” (require O2) and 3% are “critical” (ICU)
  - In the U.S.:
    - Fatality in those >85y/o = 10-27%, 65-85y/o = 3-11% and <1% in those 20-54%
    - 20-31% are hospitalized and 4.9-11.5% admitted to ICU

US Department of Health and Human Services/Centers for Disease Control and Prevention MMWR / March 27, 2020 / Vol. 69 / No. 12

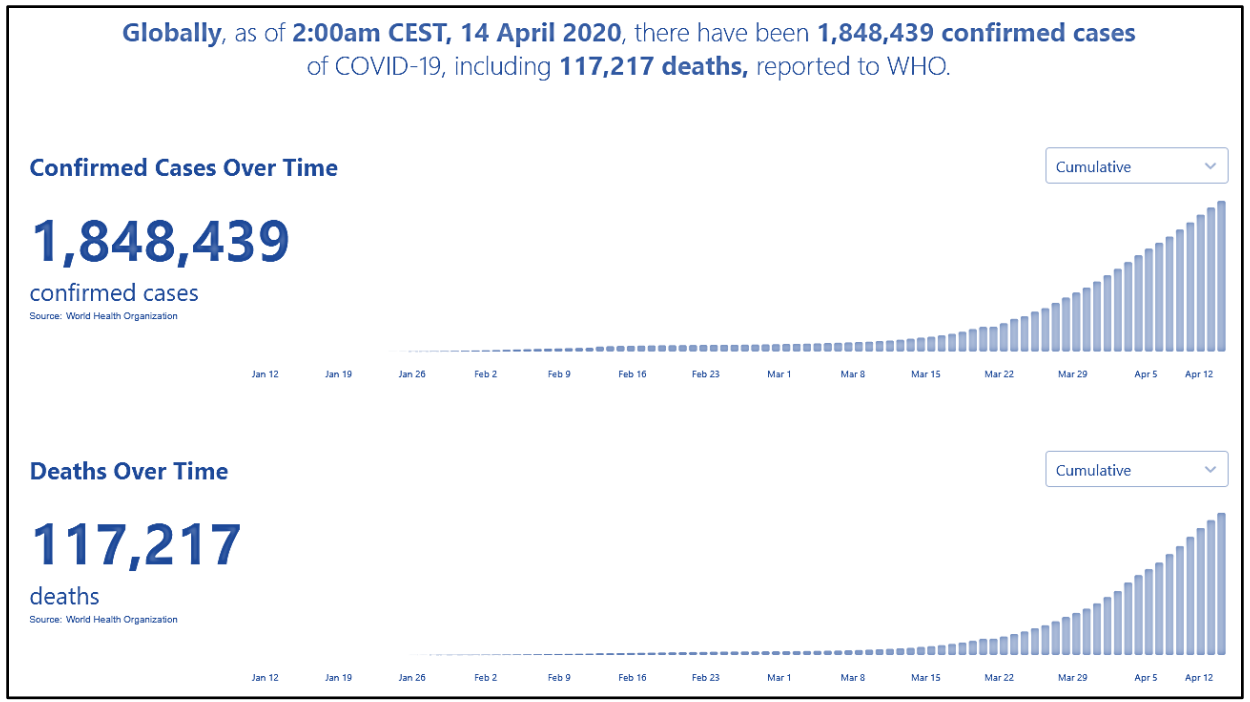
Background

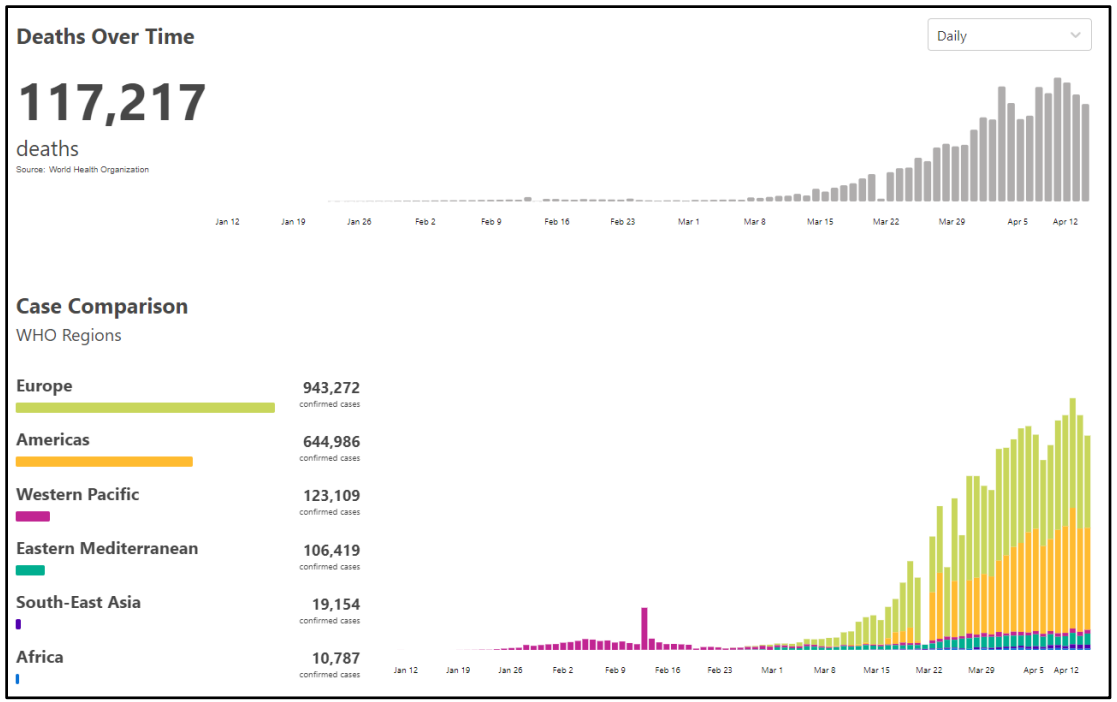
- Less fatal than Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS)
- Influenza
  - Annually about 9-45 million flu illnesses
  - 140,000-810,000 hospitalizations annually
  - 12,000-61,000 deaths annually
  - Typical years ~1 in 10000 of all flu cases die – CFR 0.01%
- COVID-19: Given the number infected it has surpassed the death count of influenza
  - 1.7million illnesses
  - 111,652 deaths [per WHO SitRep 84] (in US case fatality rate is 1.8-3.4%)

Influenza numbers are based on CDC 2010-19

COVID-19 Cases Across the Globe

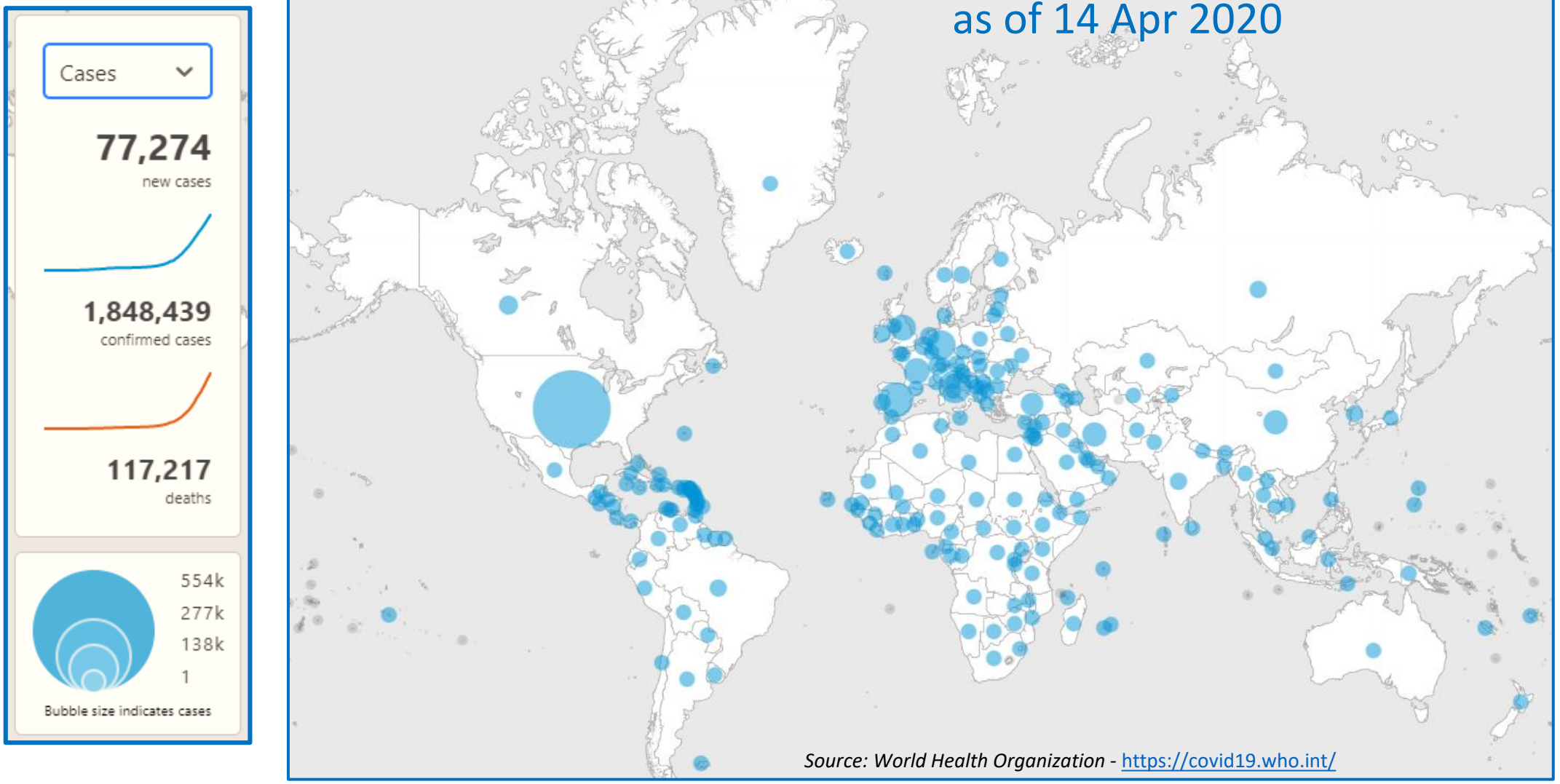
as of 14 Apr 2020





Source: World Health Organization - https://covid19.who.int/

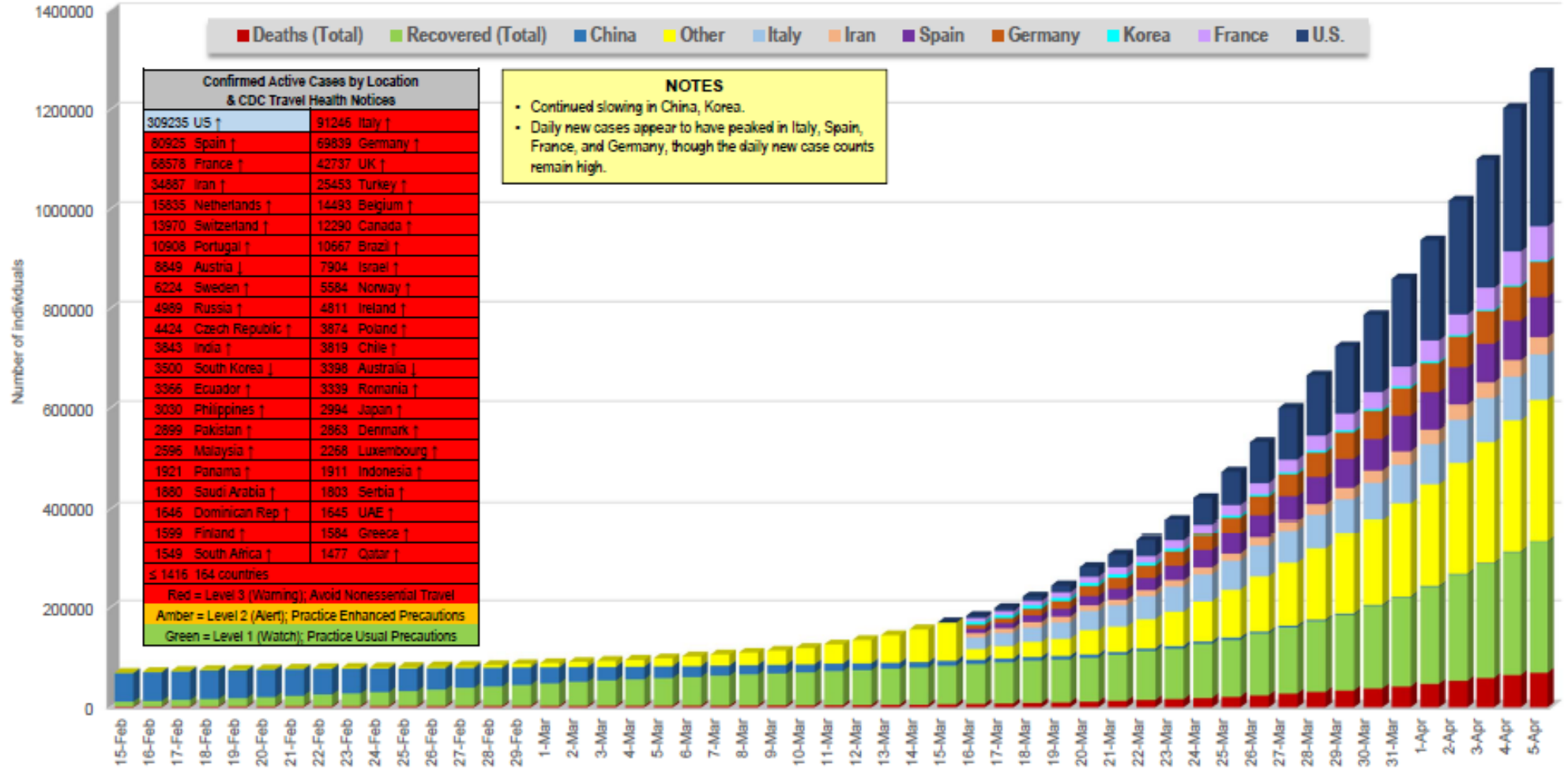
Global Map of COVID-19 Cases



Where Are We in the Spectrum?

UNCLASSIFIED

COVID-19 Cumulative Global Case Counts by Location & Status



Confirmed Active Cases by Location & CDC Travel Health Notices	
309235 US ↑	91246 Italy ↑
80925 Spain ↑	69839 Germany ↑
68578 France ↑	42737 UK ↑
34887 Iran ↑	25453 Turkey ↑
15835 Netherlands ↑	14493 Belgium ↑
13970 Switzerland ↑	12290 Canada ↑
10908 Portugal ↑	10667 Brazil ↑
8849 Austria ↓	7904 Israel ↑
6224 Sweden ↑	5584 Norway ↑
4989 Russia ↑	4811 Ireland ↑
4424 Czech Republic ↑	3874 Poland ↑
3843 India ↑	3819 Chile ↑
3500 South Korea ↓	3398 Australia ↓
3366 Ecuador ↑	3339 Romania ↑
3030 Philippines ↑	2994 Japan ↑
2899 Pakistan ↑	2863 Denmark ↑
2596 Malaysia ↑	2268 Luxembourg ↑
1921 Panama ↑	1911 Indonesia ↑
1880 Saudi Arabia ↑	1803 Serbia ↑
1646 Dominican Rep ↑	1645 UAE ↑
1599 Finland ↑	1584 Greece ↑
1549 South Africa ↑	1477 Qatar ↑
≤ 1416 164 countries	
Red = Level 3 (Warning); Avoid Nonessential Travel	
Amber = Level 2 (Alert); Practice Enhanced Precautions	
Green = Level 1 (Watch); Practice Usual Precautions	

NOTES

- Continued slowing in China, Korea.
- Daily new cases appear to have peaked in Italy, Spain, France, and Germany, though the daily new case counts remain high.

What are the Symptoms?

Fever (temp ≥ 37° C)	180 (94%)
Cough	151 (79%)
Sputum	44 (23%)
Myalgia	29 (15%)
Fatigue	44 (23%)
Diarrhea	9 (5%)
Nausea or vomiting	7 (4%)

- Lower respiratory infection
  - Cough
  - Shortness of breath
- Fever (>38° C/100.4 ° F)
- Other symptoms seen experienced in some include body aches, sore throat, runny nose and diarrhea

Incubation period:

- Range 2-14 days, most cases occur in 2-7 days and 5.2 days is mean
- Symptoms >14 days after potential exposure look for other etiologies

How is COVID-19 Spread?

- Person-to-person, appears similar to other coronaviruses and influenza
  - Mainly via respiratory droplets produced when an infected person coughs or sneezes
  - Either via mucus membrane (mouths, noses or eyes) or inhalation into the lungs.
- Able to survive on surface or object and then transfers to fingers. Touching mouth, nose or eyes contributes to transmission.
- We know some people do shed COVID-19 in their feces but how much, if any, role this plays in spreading the infection remains unknown.

Preventing Spread of COVID-19

- There are no vaccines available.
- The best way to prevent illness is to avoid being exposed to this virus (limiting travel to highly effected areas).
- CDC recommends everyday preventive actions to help prevent the spread of respiratory diseases, including:
  - **Cover your cough or sneeze with a tissue**; throw the tissue in the trash.
  - Avoid close contact with people who are sick.
  - **Avoid touching your eyes, nose and mouth**.
  - Recommend staying home when you are sick.
  - **Wash hands**

    If soap and water are not readily available, use an alcohol-based hand sanitizer with at least 60% alcohol. Always wash hands with soap and water if hands are visibly dirty.

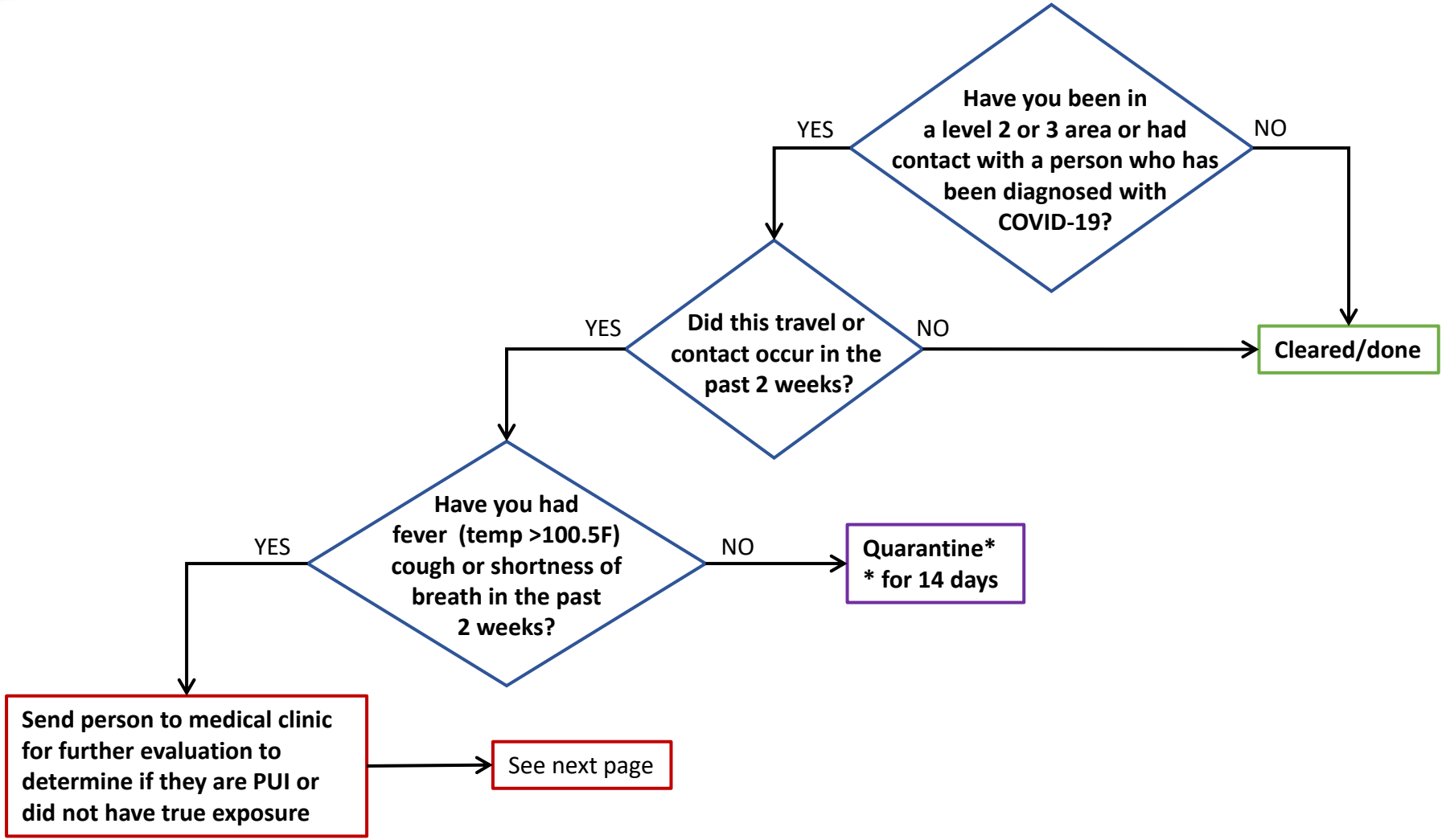
Facemask Recommendations

- CDC does not recommend people who are well wear a facemask to protect themselves from respiratory diseases, including COVID-19.
- CDC does recommend people who show symptoms AND had an exposure of COVID-19 wear facemasks to help prevent the spread of the disease to others.

Quarantine vs. Isolation

- Isolation and quarantine help protect the public by preventing exposure to people who have or may have a contagious disease.
- **Quarantine**: separates and restricts the movement of people who were exposed to a contagious disease to see if they become sick.
- **Isolation**: separates sick people with a contagious disease from people who are not sick. This is initiated by medical personnel.

Screening Algorithm



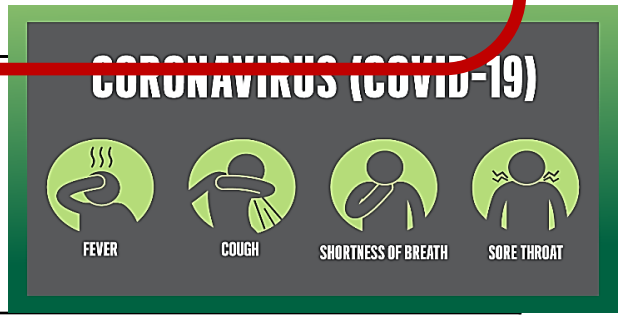
Evaluation

***Caution**: This table was abandoned in the U.S. due to widespread disease; however, it may have relevance in the deployed setting on bases with limited interaction with infected individuals and then abandoned once there is sustained spread.*

Criteria to Guide Evaluation of Person Under Investigation (PUI) for COVID-19		
Local health departments, in conjunction with clinicians, should determine whether a patient is a PUI for COVID-19. The CDC clinical criteria for COVID-19 PUIs have been developed based on available information about this novel virus, as well as what is known about SARS and MERS. These criteria are subject to change as additional information becomes available.		
Clinical Features	**&**	**Epidemiologic Risk**
Fever or signs/symptoms of lower respiratory illness (e.g., cough or shortness of breath)	**AND**	Any person, including healthcare workers, who has had close contact with a laboratory-confirmed COVID-19 patient within 14 days of symptom onset.
Fever or signs/symptoms of lower respiratory illness (e.g., cough or shortness of breath) requiring hospitalization.	**AND**	A history of travel from affected geographical areas within 14 days of symptom onset.
Fever with severe acute lower respiratory illness (e.g., pneumonia, ARDS) requiring hospitalization and without alternative explanatory diagnosis (e.g., influenza)	**AND**	No source of exposure has been identified.

Do they have an alternative diagnosis which is more likely?

- CAP: Community-acquired pneumonia
- CHF: Congestive heart failure
- URI: Upper respiratory infection



Quarantine

- Try to keep your groups small (<10)
- Total duration of time is 14 days
  - If the person remains without signs of illness
  - Unless someone in the group becomes symptomatic then reset the clock
- If they become sick remove them from quarantine and send to medical
- Have a separate latrine for them (shower and toilette)

- Unit should provide the following:
  - Food- left outside the door
  - Laundry- place in plastic bag, then dump into washer without touching
- Quarantined Person
  - Can go outside
  - Can exercise outside
  - ***May NOT go to Gym/MWR/DeFac/Chapel***
  - Does not need a mask on when in tent

Isolation

Source: Economic Times

- For monitoring +/- medical care of sick patients
  - Nursing will provide:
    - Monitoring 3x/day
    - Food
    - Medication/IVF as needed
- Full personal protective equipment (PPE) must be worn to enter
- Limit access as much as possible
- Will still need latrines for toileting
- Needs to be either in a negative pressure room or separate from the rest of the medical facility if intubated.

Isolation Levels of Care

- **Mild**: Patient you would typically send home if in your home country

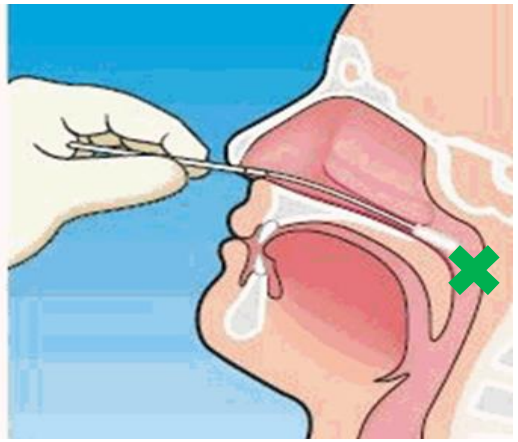
  Needs only to be checked by nurses 3 times a day to determine if progressing and to collect lab tests once asymptomatic

- **Moderate**: Patient you would typically admit to a ward
  - May require- schedule OTC medications, IVF fluid, 1-2lpm O2
  - Requires separate space but not negative pressure = utilize a ward area or rooms that will contain the patient away from other patients but is close so nursing can check on them and oxygen can be provided
- **Severe**: Patient requires ICU level care (i.e. pressors, higher flow oxygen, mechanical ventilator)

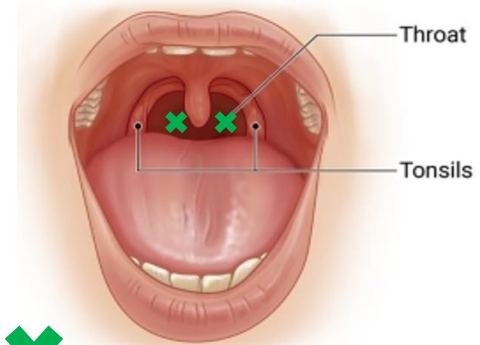
  Requires negative pressure room = utilize a separate tent

Diagnostic Testing

Nasopharyngeal (NP) swab



Oropharyngeal (OP) swab



=location for taking sample

- **Do NOT send samples to Host Nation labs or CDC.**
- **Do NOT collect sample until just prior to shipping.**
  - 72 hour limit for wet ice
  - 10-14 days on dry ice
- **Lab testing:**
  - Collect 2 swabs
    - Acceptable swabs are BD Universal Transport or HealthLink Floq Swab
    - Nasopharyngeal swab is preferred over Oropharyngeal swab. Place in 1 vial of viral transport media (VTM) together
  - 1 is for BioFire Respiratory panel
  - 1 is for BioFire COVID-19 testing (Role 3 will determine if this needs to be forwarded on to LRMC for confirmation)

Test Sample Submission

- Package the sample
- Complete the case report form
- Send on wet/dry ice

Each vial contains a NP +/- OP swab along with liquid VTM

CDC 2019-nCoV ID: _____ Form Approved: OMB: 0920-1011 Exp. 4/23/2020

.....PATIENT IDENTIFIER INFORMATION IS NOT TRANSMITTED TO CDC.....

Patient first name _____ Patient last name _____ Date of birth (MM/DD/YYYY): ___/___/_____

.....PATIENT IDENTIFIER INFORMATION IS NOT TRANSMITTED TO CDC.....

CDC

Human Infection with 2019 Novel Coronavirus
Person Under Investigation (PUI) and Case Report Form

Reporting jurisdiction: _____
Reporting health department: _____
Contact ID [a]: _____

Case state/local ID: _____
CDC 2019-nCoV ID: _____
NNDSS loc. rec. ID/Case ID [b]: _____

a. Only complete if case-patient is a known contact of prior source case-patient. Assign Contact ID using CDC 2019-nCoV ID and sequential contact ID, e.g., Confirmed case CA10203456?? has contacts CA10203456?? -01 and CA10203456?? -02. [b]For NNDSS reporters, use GenV2 or NETSS patient identifier.

Interviewer information

Name of interviewer: Last _____ First _____

Affiliation/Organization: _____ Telephone _____ Email _____

Basic information

What is the current status of this person?
- ☐ PUI, testing pending*
- ☐ PUI, tested negative*
- ☐ Presumptive case (positive local test), confirmatory testing pending*
- ☐ Presumptive case (positive local test), confirmatory tested negative*
- ☐ Laboratory-confirmed case*

*Testing performed by state, local, or CDC lab.
*At this time, all confirmatory testing occurs at CDC

Report date of PUI to CDC (MM/DD/YYYY): ___/___/_____

Report date of case to CDC (MM/DD/YYYY): ___/___/_____

County of residence: _____
State of residence: _____

Ethnicity:
- ☐ Hispanic/Latino
- ☐ Non-Hispanic/Latino
- ☐ Not specified

Sex:
- ☐ Male
- ☐ Female
- ☐ Unknown
- ☐ Other

Date of first positive specimen collection (MM/DD/YYYY): ___/___/_____
☐ Unknown ☐ N/A

Did the patient develop pneumonia?
☐ Yes ☐ Unknown ☐ No

Did the patient have acute respiratory distress syndrome?
☐ Yes ☐ Unknown ☐ No

Did the patient have another diagnosis/etiology for their illness?
☐ Yes ☐ Unknown ☐ No

Did the patient have an abnormal chest X-ray?
☐ Yes ☐ Unknown ☐ No

Was the patient hospitalized?
☐ Yes ☐ No ☐ Unknown

If yes, admission date 1 ___/___/___ (MM/DD/YYYY)
If yes, discharge date 1 ___/___/___ (MM/DD/YYYY)

Was the patient admitted to an intensive care unit (ICU)?
☐ Yes ☐ No ☐ Unknown

Did the patient receive mechanical ventilation (MV)/intubation?
☐ Yes ☐ No ☐ Unknown
If yes, total days with MV (days) _____

Did the patient receive ECMO?
☐ Yes ☐ No ☐ Unknown

Did the patient die as a result of this illness?
☐ Yes ☐ No ☐ Unknown

Date of death (MM/DD/YYYY): ___/___/_____
☐ Unknown date of death

Race (check all that apply):
- ☐ Asian
- ☐ Black
- ☐ White
- ☐ Other, specify:
- ☐ American Indian/Alaska Native
- ☐ Native Hawaiian/Other Pacific Islander
- ☐ Unknown

Date of birth (MM/DD/YYYY): ___/___/_____
Age: _____
Age units (yr/mo/day): _____

Symptoms present during course of illness:
- ☐ Symptomatic
- ☐ Asymptomatic
- ☐ Unknown

If symptomatic, onset date (MM/DD/YYYY): ___/___/_____ ☐ Unknown

If symptomatic, date of symptom resolution (MM/DD/YYYY): ___/___/_____
☐ Still symptomatic ☐ Unknown symptom status
☐ Symptoms resolved, unknown date

Is the patient a health care worker in the United States? ☐ Yes ☐ No ☐ Unknown
Does the patient have a history of being in a healthcare facility (as a patient, worker or visitor) in China? ☐ Yes ☐ No ☐ Unknown
In the 14 days prior to illness onset, did the patient have any of the following exposures (check all that apply):
- ☐ Travel to Wuhan
- ☐ Travel to Hubei
- ☐ Travel to mainland China
- ☐ Travel to other non-US country specify: _____
- ☐ Household contact with another lab-confirmed COVID-19 case-patient
- ☐ Community contact with another lab-confirmed COVID-19 case-patient
- ☐ Any healthcare contact with another lab-confirmed COVID-19 case-patient ☐ Patient ☐ Visitor ☐ HCW
- ☐ Animal exposure
- ☐ Exposure to a cluster of patients with severe acute lower respiratory distress of unknown etiology
- ☐ Other, specify: _____
- ☐ Unknown

If the patient had contact with another COVID-19 case, was this person a U.S. case? ☐ Yes, nCoV ID of source case: _____ ☐ No ☐ Unknown ☐ N/A

Under what process was the PUI or case first identified? (check all that apply): ☐ Clinical evaluation leading to PUI determination
☐ Contact tracing of case patient ☐ Routine surveillance ☐ EpiX notification of travelers; if checked, DGMQID _____
☐ Unknown ☐ Other, specify: _____

Interpretation of Results

- **A Positive is positive**: If the test comes back positive the PUI is now diagnosed with COVID-19 and needs to remain in isolation until time completed (see separate slide)
  - Additionally, persons quarantined b/c of this patient need to remain in quarantine for the full 14 days
- **A Negative does not clear them of diagnosis** as there is a rate of false negative. Re-assess the patient.
  - If symptoms are still concerning for COVID keep the patient in isolation until time completed.
    - *Quarantined individuals must complete 14 days.*
  - If symptoms are clearly more consistent with an alternative diagnosis then (per CJTF-OIR guidance) then consider continuing quarters for 48 hours or only completing 7 days of isolation
    - *Quarantined individual can be released early.*

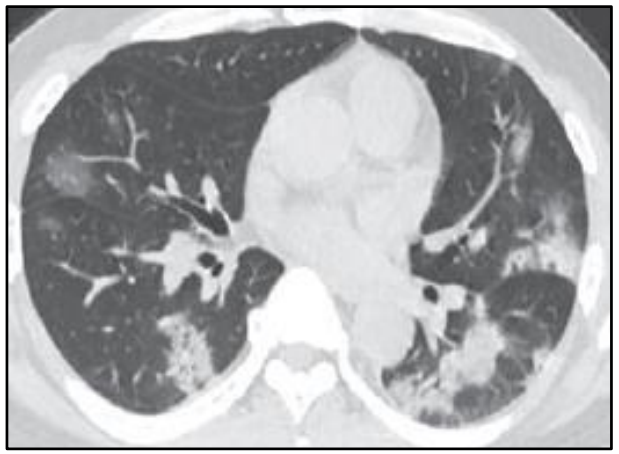
False Negatives

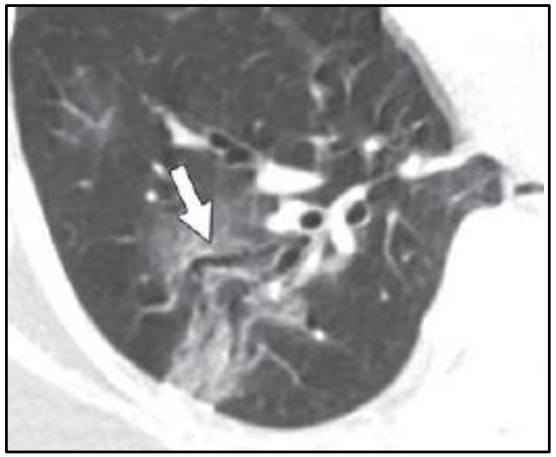
- When diagnostic testing is negative, the possibility of a false negative result should be considered in the context of a patient's recent exposures and the presence of clinical signs and symptoms consistent with COVID-19. *(Fact Sheet for Healthcare Providers, ID NOW COVID-19- Abbott Diagnostics Scarborough, Inc. Mar 27, 2020.)*
  - The possibility of a false negative result should especially be considered if the patient's recent exposures or clinical presentation indicate that COVID-19 is likely, and diagnostic tests for other causes of illness (e.g., other respiratory illness) are negative.
  - If COVID-19 is still suspected based on exposure history together with other clinical findings, re-testing should be considered by healthcare providers in consultation with public health authorities.
- A false negative BioFire COVID-19 test result may occur when the concentration of virus in the sample is below the device limit of detection. *(Source: BioFire Defense, LLC)*
  - Detection of viral nucleic acid is dependent upon proper sample collection, handling, transportation, storage and preparation. Failure to observe proper procedures in any one of these steps can lead to incorrect results.

Radiology

ACR recommendations for the use of chest radiology and computed tomography (CT) for suspected COVID-19 infection, Mar 11, 2020

- CXR findings in COVID-19 are non-specific and overlap with other infections
- "CT should be used sparingly and reserved for hospitalized symptomatic patients with specific clinical indications for CT."





Cavitation and tree-in-bud favor alternative etiology

CT features of COVID-19 pneumonia in 62 patients in Wuhan, China, Mar 5, 2020

Mixed and diverse pattern

- <7 days
  - 72% air bronchograms
  - 40% GGO, 34% consolidation, 62% GGO + reticular pattern
  - 10% pleural effusion
- Later phase (8-14 days)
  - Progression of GGO, bronchus distortion & effusion
- Advanced-phase
  - GGO decreases
  - 22% pleural effusion

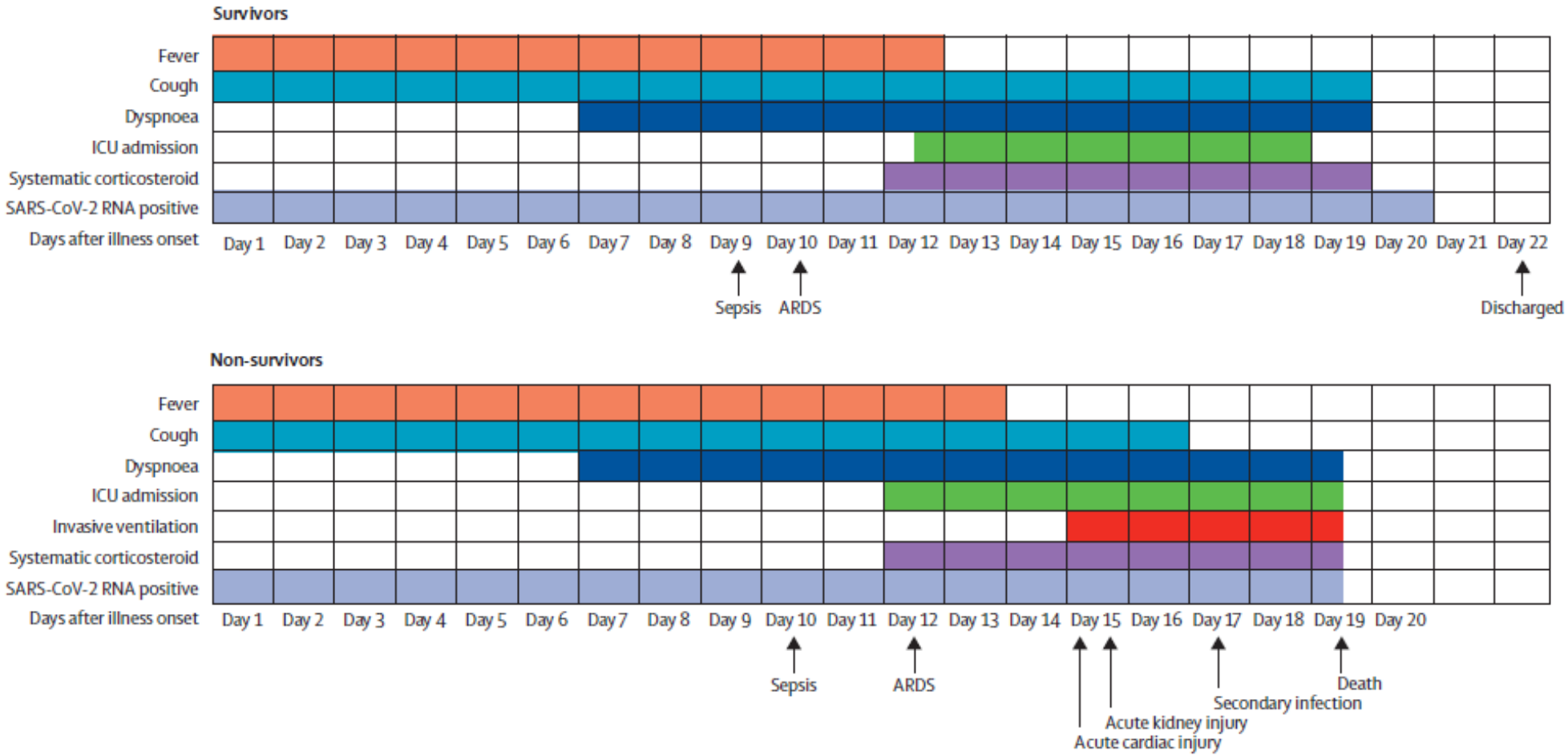
Clinical Course

Common symptoms:
Fever, cough, sputum production, fatigue

Complications:
Sepsis > resp failure/ARDS > heart failure, shock, coagulopathy > AKI, secondary infection

Death vs discharge:

- 18.5 days vs 22 days
- Atherosclerosis directly contributing to plaque rupture vs potential direct cardiac involvement of the virus



Predicting Severity of Illness

Clinical characteristics of 138 hospitalized patients with 2019 novel Coronavirus-infected pneumonia in Wuhan, China, Feb 7, 2020

- D-dimer >1mcg/L, LDH, Ti, Ferritin
- Having a comorbidity: HTN, DM, CAD, COPD, CKD
- Age
- High SOFA score
  - P:F, PLT, Bili, MAP, GCS, creatine
- CURB-65 >3-5
  - Confusion, uremia, RR>30, SBP <90, Age >65
- Procalcitonin not helpful

Relation between chest CT findings and clinical conditions of COVID-19 pneumonia: a multicenter study, Mar 5, 2020

Extent of lung involvement correlates with the severity of symptoms and prognosis of the patient.

Treatment

- There are **no antivirals** available
- Supportive (treat similar to flu)
  - Tylenol for fever
  - Motrin for pain?
  - Anti-vomiting medication
  - IVF (should be conservative if acute respiratory infection is present)
- Sepsis Physiology
  - Vasopressors
    - 1st line norepi
    - 2nd line epi or vasopressin
- If sepsis consider co-infection: Start empiric antibiotics within 1 hour of sepsis (community acquired pneumonia vs hospital acquired pneumonia).
- Therapy to avoid: Steroids
- Investigational
  - Remdesivir
  - Other antivirals

Respiratory Treatment

- Avoid
  - High flow nasal cannula (HFNC) - results in aerosolization
  - Non-invasive positive pressure ventilation (NPPV) - not a rapidly reversible process)
- Options
  - NC O2 (goal >94% sat)
  - Mechanical Ventilation
    - ARDS net protocol: low TV 4-6ml/kg and positive end-expiratory pressure (PEEP)
    - Paralysis
    - Proning 12-16 hrs/day

Lower PEEP/higher FIO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

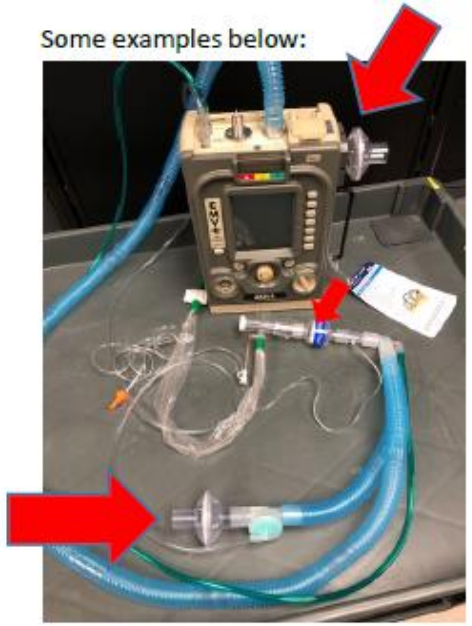
- When all fails consider extracorporeal membrane oxygenation (ECMO)

Ventilators

Zoll 731 and LTV 1000 reasonable vents to use for COVID in deployment as they allow adjustment of volume, provide PEEP, & can provide 100% FiO2

Ventilator model	Hamilton T1	Zoll 731 (EMV+, Eagle II)	Impact 754 (Eagle/ UniVent)	SAVe I	SAVe II	LTV 1000	PB 980
ASV	√						
AC		√	√			√	√
SIMV	√	√	√			√	√
CPAP		√	√			√	√
BL (BiPAP)		√					√
Control (backup)			√			√	
CMV	√			√	√	√	
Breaths/min	1 - 80	1 - 80	1 - 150	fixed 10	8 - 30	1 - 80	1 - 100
I:E ratio	1:1.9 - 1:4.1	1:1 - 1:99.9	1:1 - 1:599	1:2	1:2	1:.99 - 4:1	1:1 - 1:299
Inverse I:E	X	Ti 0.1 - 5.0	X	no	no	X	2:1 - 149:1
Tidal Volume (mls)	20 - 2000mL	50 - 1500mL	0 - 3000mL	fixed 600mL	200 - 800	50 - 2000	25 - 2500
PIP (cmH2O)	0 - 60	10 - 80	0 - 100	38	10 - 60	0 - 120	0 - 125
PEEP (cmH2O)	0 - 35	0 - 30 (AC modes)	1 - 20	0 (< 2)	0 - 10	3 - 40	0 - 45
PS (cmH2O	0 - 60	0 - 60 (SIMV, CPAP)	X	X	X	1 - 60	0 - 70
FiO2	21 - 100%	21 - 100%	21 - 100%	21 - 62%	21 - 100%	21 - 100%	21 - 100%
Maximum Flow Rate (LPM)	80	100 @ 40 cmH2O PIP	60	16	36	100	150

Some examples below:



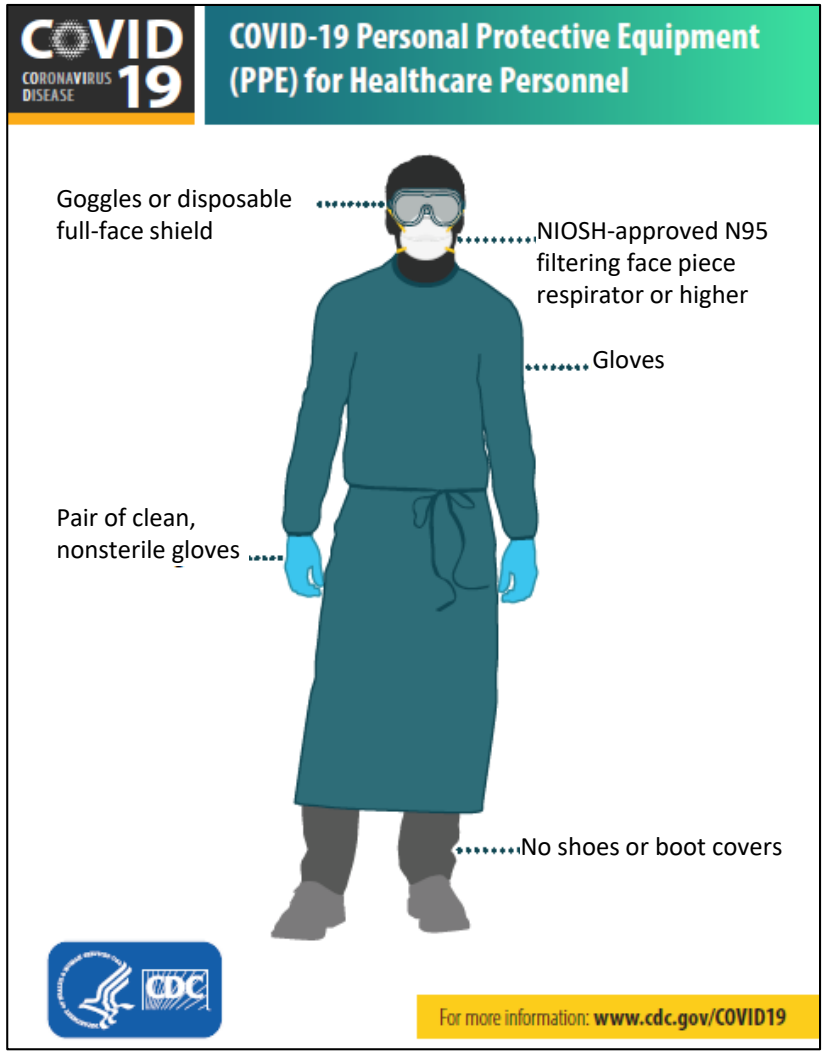
Optimal location of filters for humidification and decreasing viral aerosol

POC: Dr. Pat Meza
patricia.n.meza.ctr@mail.mil

Treatment Considerations

- Enteral nutrition
- H2 blocker if at risk of ulcer
- Turning patients every 2 hours
- Central line placement
- A-line

Caring for COVID-19 Patient



- Healthcare workers should wear the following:
  - Gloves
  - N-95
  - Gown
  - Eye protection
- Healthcare workers should avoid touching their own skin until all PPE is off and they have washed their hands.
- Change PPE when switching to a new patient
  - N-95 can be rotated each day (A, B, C, D) and then re-used on day 5
  - Googles can be worn and cleaned at the end of each day

Isolation Discharge Criteria

1. 7 days from diagnosis have passed

   plus

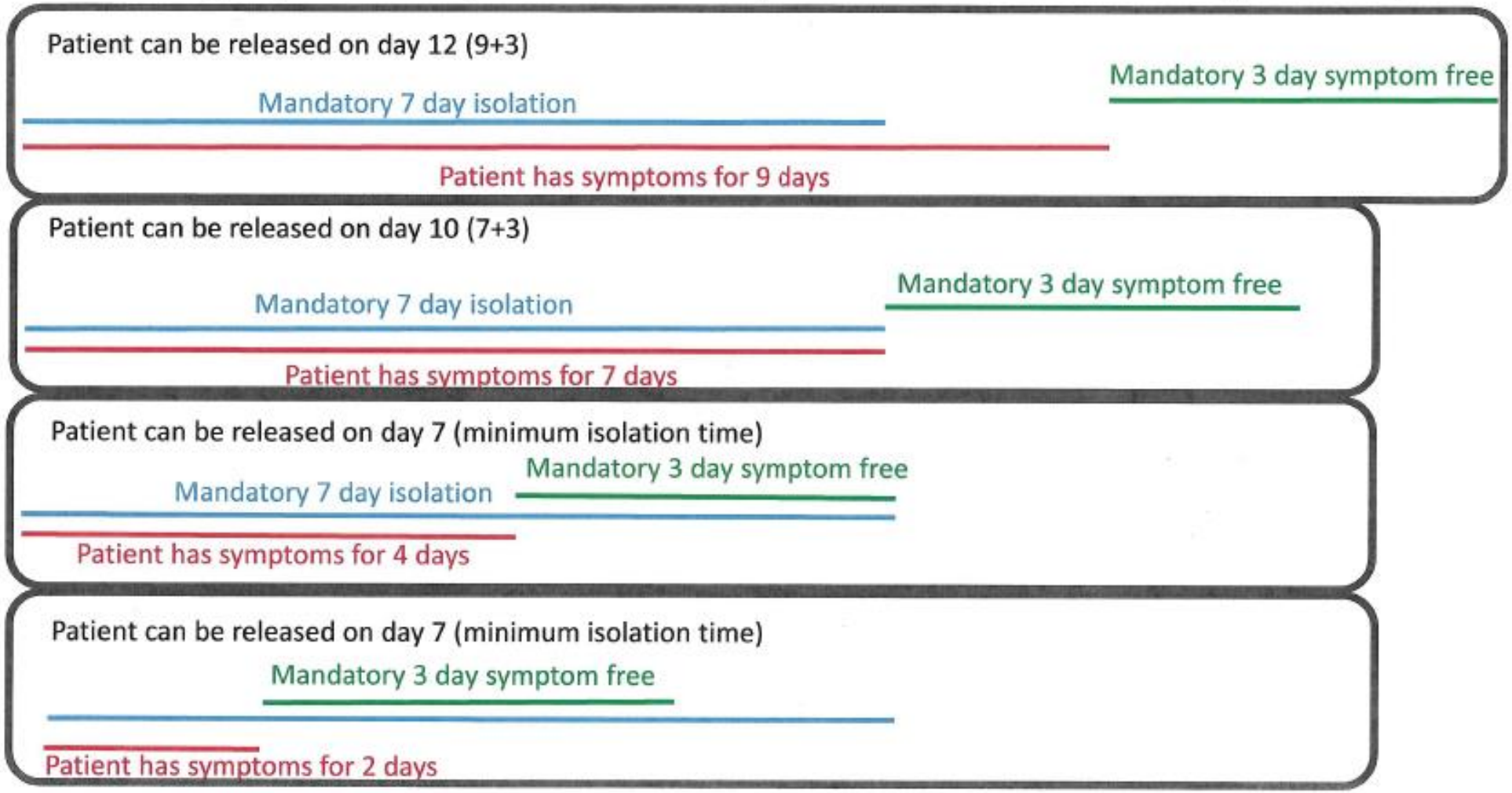
2. Resolution of fever for 72 hours (also must be off antipyretic)

   plus

3. Improvement/resolution of systemic & respiratory symptoms (may still have a lingering cough)

Patient's level of medical care may be stepped-down at any time, but they must remain in isolation until all 3 criteria are met.

Time-based release from Isolation



Survivability on Surfaces

Coronavirus Disease 2019, Survival of SARS-CoV-2 on environmental surfaces

- Survivability of coronaviruses is variable
  - Ideal conditions, 4^{o}C and 20% humidity, some live for 28 days on steel surface
  - At room temp metal, cloth & filter paper do not have detectable virus on d5 but were not found on wood, glass, mosaic, plastic
  - Once dried on plastic: viable up to 5 days
  - Survive longer in cold dry weather
  - Direct UV light from the sunshine helps kill the virus
- SARS/MERS variable on surfaces 24 -72 hours

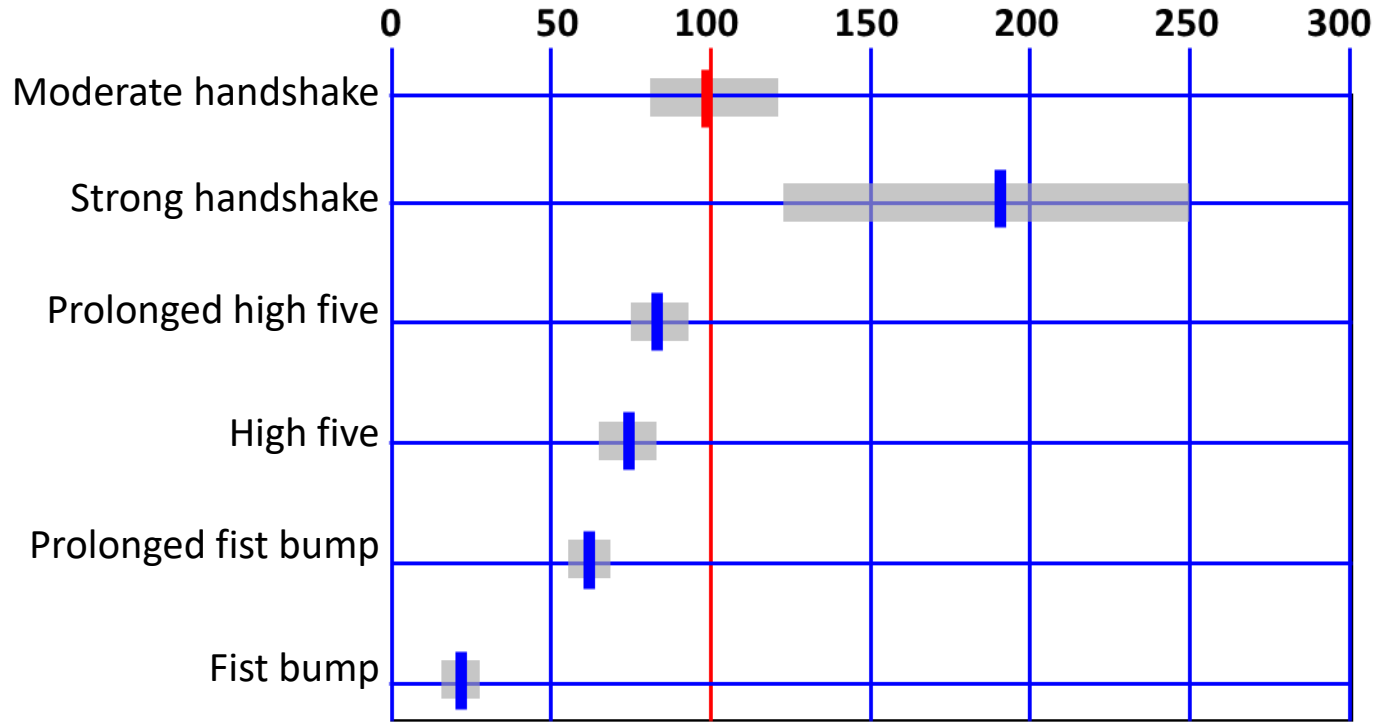
Infection Control

- Surfaces- daily
- Wipe down daily "high-touch" surfaces, such as counters, tabletops, doorknobs, bathroom floors/sinks/showers, toilets, phones, keyboards, tables, light switches.
  - Can use disinfectant on a sponge or rag or use disposable sanitary wipes.
  - EPA web site has a list of approved products.
- Use a diluted bleach solution
  - To make a bleach solution, add 60 mL (2 oz) of bleach to 4 L of water.
- Linens: Make sure they are laundered in between use, dryer should be “hot” temp.
- Hands: Alcohol-based hand disinfectants and common hospital personal disinfectants are all effective against COVID-19.
  - Reuse frequently, especially before touching your face or eyes

Questions

Pressing the flesh

Transfer of bacteria relative to a moderate-strength handshake, %



Source: The fist bump is more hygienic alternative to the handshake by S. Mela, D. Whitworth, American Journal of Infection Control, The Economist, 2014.

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